United States General Accounting Office

GAO

Fact Sheet for the Chairman, Subcommittee on Environment, Energy, and Natural Resources, Committee on Government Operations, House of Representatives

August 1986

FEDERAL ELECTRIC POWER

Repairs Made on Turbines at Two Arkansas River Dams

GAO/RCED-86-208FS

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-223835

August 28, 1986

The Honorable Mike Synar
Chairman, Subcommittee on Environment,
Energy, and Natural Resources
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

In February 1986 your office asked us to examine certain information related to the repair of eight electricity-generating turbines at two U.S. Army Corps of Engineers (Corps) projects--Ozark Dam and Webbers Falls Dam, located on the Arkansas River. These projects produce power that is marketed by the Southwestern Power Administration (SWPA). Specifically, we agreed to obtain information on (1) the current status of the power-generating units at the two projects and (2) the basis for the Corps' decision to pay for the repairs rather than seek legal recourse against the turbine manufacturer. On June 20, 1986, we briefed your office on the information we had obtained. At that time, we agreed to provide you with a fact sheet on the results of our inquiry. Information we obtained on the above two matters is contained in the following section.

In summary, all eight turbines at these two projects have been repaired and were in service as of May 23, 1986. No additional problems related to the repairs had occurred as of that date. The Corps considered litigation against the manufacturer of the turbines on the basis of latent design defects. However, no action was initiated because the turbine manufacturer's contention that the failures were due to defects that were beyond the state-of-the-art of turbine design in the late 1960's was supported by a consultant under contract to the Corps.

The information in the following section was obtained through discussions with officials from the Corps and SWPA and a review of pertinent documents and records provided by these officials. We also reviewed congressional hearings at which the Corps testified on these issues. Our review was performed between May and June 1986.

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As arranged with your office, unless you publicly announce its contents earlier, we will not distribute this fact sheet further until 30 days from the date of this letter.

Sincerely yours,

Keith O. Fultz
Associate Director

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ABBREVIATIONS

Corps	U.S. Army Corps of Engineers
GAO	General Accounting Office
psi	per square inch
SWPA	Southwestern Power Administration

Item 1

THE CURRENT STATUS OF POWER-GENERATING UNITS AT OZARK DAM AND WEBBERS FALLS DAM

According to the Corps, all eight power-generating units at these two projects were in service and, as of May 23, 1986, have operated satisfactorily since repairs were completed between November 1982 and April 1985. Table 1.1 shows the date each unit was declared unavailable in order to repair damaged turbine shafts, the date it was returned to service, and the hours of operation before and since it was repaired.

Table 1.1: Time Periods Associated with Turbine Shaft Repairs at Ozark Dam and Webbers Falls Dam and Hours of Turbine Operation

Unit number	Date unavailable for power production	Date unit returned to service	Hours of operation As of early 1980[a]	Hours of operation Since repairs[b]
Ozark				
#4	8-04-80	11-17-82	12,808	16,285
#5	8-11-80	11-24-84	21,916	10,274
#1	8-18-80	8-02-83	24,766	16,065
#3	11-26-80	3-09-84	29,869	11,933
#2	7-18-81	4-25-85	13,021	6,517
Webbers Falls				
#1	4-21-80	2-03-83	30,849	18,521
#3	6-02-80	12-12-84	22,957	9,219
#2	6-03-80	10-02-83	29,459	14,988

[a]Ozark hours are based on inspection readings made Jan. 1, 1980 and Webbers Falls hours are based on readings made Mar. 1, 1980.

[b]Hours of operation since repairs are through the end of April 1986.

Item 2

THE BASIS FOR THE CORPS' DECISION TO PAY FOR THE TURBINE REPAIRS AT OZARK DAM AND WEBBERS FALLS DAM

Early this year, Corps officials testified at House appropriation hearings that damages could not be sought from the manufacturer for the turbine repairs at these projects because the manufacturer's warranty associated with the turbines had expired before the failures occurred. According to a Corps official, the Corps believed a law suit based on latent design defects would not be successful because of the manufacturer's claim that the cause of the failures was beyond the state-of-the-art of turbine design in the late 1960's.

Ozark Dam and Webbers Falls Dam were designed and constructed under the supervision of the Corps on the McClellan-Kerr Arkansas River Navigation System. Between 1970 and 1972, eight identical 20-megawatt, slant-axis, power-generating units were installed at these projects. These units were considered innovative by the Corps in that they were the first large slant-axis units to be installed at a hydroelectric project in the United States.

Beginning in 1975, failures occurred in various parts of the rotating assembly in two of the turbines. In 1976 cracks were found in a welded joint on the main shaft of one turbine, and it was welded in place. Between 1976 and 1979, the Corps held discussions concerning this problem and performed studies and tests on the units. On April 20, 1980, cracks were found in a Webbers Falls unit, and subsequent ultrasonic testing revealed that similar cracking had occurred in the welded joints of all the units.

The Corps held a meeting on April 28, 1980, to determine a plan of action for repairing the damaged Webbers Falls unit and modifying the other turbines. The Corps decided to employ the Franklin Research Center to study the Webbers Falls turbine failures. The Center's study results, reported to the Corps on August 12-13, 1980, showed that the fatigue-life of the turbine shafts appeared to be inadequate, given the stress concentration occurring at the weld joint. At that time the Corps asked the Center representatives if, given the "state-of-the-art" in 1965, they would have considered the fatigue-life aspects of the welded joint to be cause for concern had they been designing these turbines. All three Center representatives gave negative replies. According to a Corps official present at that meeting, the Center representatives' opinions provided a turning point in the Corps' efforts to seek litigation against the turbine manufacturer. Subsequently, the Corps decided against litigation, and a contract was negotiated with the manufacturer for the redesign and repair of the shafts.

To assist in the redesign and repair effort, the Corps contacted the Shafting Design Section, U.S. Naval Sea Command, for advice and suggestions based on its experience with similar problems in slant-axis shaft turbines used on ships. As a result of those discussions, a retired former Chief of the Shafting Design Section was hired as a consultant to review the final shaft design and suggest any improvements based on his experience.

A key element of the new design of the turbine slant-axis shafts included consideration that nominal bending stress of shafts exposed to corrosive water must be limited to 4,000 pounds per square inch (psi) in order to prevent cracking. The consultant's report to the Corps indicated that the British Navy had considered this factor in designing ship shafts and has had no broken shafts in its ships since the end of World War II. According to a Corps official, when the power-generating turbines were designed and built, the 4,000 pounds psi stress-limitation for ship shafts was common knowledge among Naval engineers. However, within the hydropower industry, vertical shaft turbines had reached stress levels of 15,000 pounds psi and, according to this official, little was known about the additional stress on large hydropower slant-axis shafts when the units were installed.

According to figures obtained from agency officials, in May 1986 the estimated cost of repairing these turbines was about $11.7 million. In addition, according to SWPA's Branch Chief for Power Resource Production, the value of the energy lost because of turbine shaft repairs is $31.7 million ($20.5 million for power purchased by SWPA and $11.2 million for lost sales).

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